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Via email: **sgeorge@davidjpowers.com**

Subject: **Santa Clara University Expansion Plan, Santa Clara, CA – Construction Noise and Vibration Assessment**

Dear Ms. George:

Santa Clara University has developed a new plan for expansion over the next five years, which would include construction of new buildings on existing parking lots, demolition of existing buildings for new construction, and the partial closure of a roadway. The main campus is located to the west of El Camino Real between Benton Street and The Alameda in Santa Clara, California. Four major construction projects and four secondary projects are included in the Expansion Plan.

The first major construction project (Project 1) is a new law school proposed to be located on an existing parking lot located along Franklin Street east of Lucas Hall. The proposed four-story building would be a maximum of 95,000 square feet and consist of offices as well as classrooms. Project 2, which is also considered a major project, would be the Science, Technology, Engineering, and Mathematics (STEM) Center. As part of Project 2, five existing buildings would be demolished, and four separate structures would replace the existing buildings in a total of three phases. The project sites for Project 2 are located south of the Abby Sobrato Mall. Two new four-story residence halls are proposed for Project 3. One residence hall would be constructed at the site of an existing parking lot, and the other would replace an existing building. Project 4 consists of replacing the existing Cowell Center with a two-story building that would provide space for Student Health Services and practice space for NCAA athletes and recreational sports.

The first of the secondary projects include the demolition of the Daly Science Center (Project 5) once the new STEM Center has been completed. No development is planned for this site. Project 6 includes adding 49,000 square feet along the north, east, and west of the existing Benson Center, which is used for meeting and dining space, as well as common areas for students. Project 7 proposes an expansion to the north and west of the existing Pat Malley Fitness Center. Under Project 8, the vacation of the portion of Market Street/The Alameda between Lafayette Street and Bellomy Street would be requested. Vehicular traffic would be limited to emergency access and deliveries to the Benson Center.

A noise monitoring survey of the existing noise environment was conducted on Tuesday, July 21, 2015. The results of this survey were used to determine specific acoustical recommendations regarding construction noise and vibration control at surrounding sensitive receptors. This report includes a discussion of results from the noise monitoring survey, summarizes construction noise and vibration levels expected for the proposed project, and describes measures necessary to reduce noise and vibration levels to acceptable levels.

Fundamentals of Environmental Noise

Noise may be defined as unwanted sound. Noise is usually objectionable because it is disturbing or annoying. The objectionable nature of sound could be caused by its *pitch* or its *loudness*. *Pitch* is the height or depth of a tone or sound, depending on the relative rapidity (frequency) of the vibrations by which it is produced. Higher pitched signals sound louder to humans than sounds with a lower pitch. *Loudness* is intensity of sound waves combined with the reception characteristics of the ear. Intensity may be compared with the height of an ocean wave in that it is a measure of the amplitude of the sound wave.

In addition to the concepts of pitch and loudness, there are several noise measurement scales which are used to describe noise in a particular location. A *decibel (dB)* is a unit of measurement which indicates the relative amplitude of a sound. The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. Sound levels in decibels are calculated on a logarithmic basis. An increase of 10 decibels represents a ten-fold increase in acoustic energy, while 20 decibels is 100 times more intense, 30 decibels is 1,000 times more intense, etc. There is a relationship between the subjective noisiness or loudness of a sound and its intensity. Each 10 decibel increase in sound level is perceived as approximately a doubling of loudness over a fairly wide range of intensities. Technical terms are defined in Table 1.

There are several methods of characterizing sound. The most common in California is the *A-weighted sound level (dBA).* This scale gives greater weight to the frequencies of sound to which the human ear is most sensitive. Representative outdoor and indoor noise levels in units of dBA are shown in Table 2. Because sound levels can vary markedly over a short period of time, a method for describing either the average character of the sound or the statistical behavior of the variations must be utilized. Most commonly, environmental sounds are described in terms of an average level that has the same acoustical energy as the summation of all the time-varying events. This *energy-equivalent sound/noise descriptor* is called L_{eq}. The most common averaging period is hourly, but L_{eq} can describe any series of noise events of arbitrary duration.

The scientific instrument used to measure noise is the *sound level meter*. Sound level meters can accurately measure environmental noise levels to within about plus or minus 1 dBA. Various computer models are used to predict environmental noise levels from sources, such as roadways and airports. The accuracy of the predicted models depends upon the distance the receptor is from the noise source. Close to the noise source, the models are accurate to within about plus or minus 1 to 2 dBA.

Since the sensitivity to noise increases during the evening and at night -- because excessive noise interferes with the ability to sleep -- 24-hour descriptors have been developed that incorporate artificial noise penalties added to quiet-time noise events. The *Community Noise Equivalent Level* (*CNEL*) is a measure of the cumulative noise exposure in a community, with a 5 dB penalty added to evening (7:00 p.m. - 10:00 p.m.) and a 10 dB addition to nocturnal (10:00 p.m. - 7:00 a.m.) noise levels. The *Day/Night Average Sound Level* (L_{dn}) is essentially the same as CNEL, with the exception that the evening time period is dropped and all occurrences during this three-hour period are grouped into the daytime period.

Fundamentals of Ground-borne Vibration

Ground vibration consists of rapidly fluctuating motions or waves with an average motion of zero. Several different methods are typically used to quantify vibration amplitude. One method is the Peak Particle Velocity (PPV). The PPV is defined as the maximum instantaneous positive or negative peak of the vibration wave. In this report, a PPV descriptor with units of mm/sec or in/sec is used to evaluate construction generated vibration for building damage and human complaints. Table 3 displays the reactions of people and the effects on buildings that continuous vibration levels produce.

The annoyance levels shown in Table 3 should be interpreted with care since vibration may be found to be annoying at much lower levels than those shown, depending on the level of activity or the sensitivity of the individual. To sensitive individuals, vibrations approaching the threshold of perception can be annoying. Low-level vibrations frequently cause irritating secondary vibration, such as a slight rattling of windows, doors, or stacked dishes. The rattling sound can give rise to exaggerated vibration complaints, even though there is very little risk of actual structural damage.

Construction activities can cause vibration that varies in intensity depending on several factors. The use of pile driving and vibratory compaction equipment typically generates the highest construction related ground-borne vibration levels. Because of the impulsive nature of such activities, the use of the PPV descriptor has been routinely used to measure and assess ground-borne vibration and almost exclusively to assess the potential of vibration to induce structural damage and the degree of annoyance for humans.

The two primary concerns with construction-induced vibration, the potential to damage a structure and the potential to interfere with the enjoyment of life, are evaluated against different vibration limits. Studies have shown that the threshold of perception for average persons is in the range of 0.008 to 0.012 in/sec PPV. Human perception to vibration varies with the individual and is a function of physical setting and the type of vibration. Persons exposed to elevated ambient vibration levels, such as people in an urban environment, may tolerate a higher vibration level.

Structural damage can be classified as cosmetic only, such as minor cracking of building elements, or may threaten the integrity of the building. Safe vibration limits that can be applied to assess the potential for damaging a structure vary by researcher and there is no general consensus as to what amount of vibration may pose a threat for structural damage to the building. Construction-induced vibration that can be detrimental to the building is very rare and has only been observed in instances where the structure is at a high state of disrepair and the construction activity occurs immediately adjacent to the structure.

TABLE 1 Definition of Acoustical Terms Used in this Report

Term	Definition
Decibel, dB	A unit describing, the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20 micro Pascals.
Sound Pressure Level	Sound pressure is the sound force per unit area, usually expressed in micro Pascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressures exerted by the sound to a reference sound pressure (e. g., 20 micro Pascals). Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, Hz	The number of complete pressure fluctuations per second above and below atmospheric pressure. Normal human hearing is between 20 Hz and 20,000 Hz. Infrasonic sound are below 20 Hz and Ultrasonic sounds are above 20,000 Hz.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
L_{01}, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Day/Night Noise Level, L_{dn} or DNL	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 p.m. and 7:00 a.m.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 p.m.to 10:00 p.m. and after addition of 10 decibels to sound levels measured in the night between 10:00 p.m. and 7:00 a.m.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Source: Handbook of Acoustical Measurements and Noise Control, Harris, 1998.

TABLE 2 Typical Noise Levels in the Environment

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	110 dBA	Rock band
Jet fly-over at 1,000 feet		
	100 dBA	
Gas lawn mower at 3 feet		
	90 dBA	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	80 dBA	Garbage disposal at 3 feet
Noisy urban area, daytime		
Gas lawn mower, 100 feet	70 dBA	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	60 dBA	
		Large business office
Quiet urban daytime	50 dBA	Dishwasher in next room
Quiet urban nighttime	40 dBA	Theater, large conference room
Quiet suburban nighttime		
	30 dBA	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	20 dBA	
		Broadcast/recording studio
	10 dBA	
	0 dBA	

Source: Technical Noise Supplement (TeNS), California Department of Transportation, September 2013.

TABLE 3 Reactions of People and Damage to Buildings from Continuous or Frequent Intermittent Vibration Levels

Velocity Level, PPV (in/sec)	Human Reaction	Effect on Buildings
0.01	Barely perceptible	No effect
0.04	Distinctly perceptible	Vibration unlikely to cause damage of any type to any structure
0.08	Distinctly perceptible to strongly perceptible	Recommended upper level of the vibration to which ruins and ancient monuments should be subjected
0.1	Strongly perceptible	Virtually no risk of damage to normal buildings
0.3	Strongly perceptible to severe	Threshold at which there is a risk of damage to older residential dwellings such as plastered walls or ceilings
0.5	Severe - Vibrations considered unpleasant	Threshold at which there is a risk of damage to newer residential structures

Source: Transportation and Construction Vibration Guidance Manual, California Department of Transportation, September 2013.

Regulatory Criteria

The proposed project would be subject to noise-related regulations, plans, and policies established within documents prepared by the City of Santa Clara. Applicable planning documents include the City's General Plan and Municipal Code.

City of Santa Clara General Plan Noise Element. The City of Santa Clara's General Plan establishes policies to control noise within the community. Applicable goals and policies presented in the General Plan are as follows:

5.10.6-P4 Encourage the control of noise at the source through site design, building design, landscaping, hours of operation and other techniques.

5.10.6-P5 Require noise-generating uses near residential neighborhoods to include solid walls and heavy landscaping along common property lines, and to place compressors and mechanical equipment in sound-proof enclosures.

City of Santa Clara Municipal Code. The City's Municipal Code establishes noise level performance standards for fixed sources of noise. Section 9.10.40 of the Municipal Code limits noise levels at single- and multi-family residences to 55 dBA during daytime hours (7:00 a.m. to 10:00 p.m.) and 50 dBA at night (10:00 p.m. to 7:00 a.m.). The noise limits are not applicable to emergency work, licensed outdoor events, City-owned electric, water, and sewer utility system facilities, construction activities occurring within allowable hours, permitted fireworks displays, or permitted heliports. According to section 9.10.230 of the Municipal Code, construction activities are not permitted within 300 feet of residentially zoned property except within the hours of 7:00 a.m. and 6:00 p.m. on weekdays and 9:00 a.m. and 6:00 p.m. on Saturdays. No construction is permitted on Sundays or holidays.

The City Code does not define the acoustical time descriptor such as L_{eq} (the average noise level) or L_{max} (the maximum instantaneous noise level) that is associated with the above limits. A reasonable interpretation of the City Code would identify the ambient base noise level criteria as an average or median noise level (L_{eq}/L_{50}).

Existing Noise Environment

Santa Clara University is located west of El Camino Real between The Alameda and Benton Street in Santa Clara, California. The expansion project includes various locations throughout the campus that are identified in Figure 1. The STEM Complex, Daly Science building, New Cowell Center, and Malley additions are located on the interior of the campus and would be surrounded by buildings and facilities associated with the University. The new law school building, however, is located on the northern border of campus along Franklin Street. Opposite Franklin Street from the new law school building would be single- and multi-family residences. The Benson Center and Dunne Hall Mods additions, which would be in the southwest corner of campus at the corner of Lafayette Street and Market Street, are adjacent to on-campus residential buildings. Opposite Lafayette Street and Market Street are single- and multi-family residences, as well as local offices. The project sites for the new student housing buildings A and B are located north of the intersection of El Camino Real and The Alameda on the south end of campus. Opposite The Alameda and the nearby Park Avenue is an existing supermarket, other commercial retail and restaurants, and single- and multi-family residences.

A noise monitoring survey was performed at the site on Tuesday July 21, 2015 and included four short-term noise measurements, as shown in Figure 1. The noise environment at the site and in the surrounding areas results primarily from vehicular traffic along El Camino Real, The Alameda, Lafayette Street, Market Street, and Benton Street. Local traffic on the side streets and occasional aircraft associated with the Mineta San José International Airport also affect the noise environment at and surrounding the campus.

Each of the short-term noise measurements were made on Tuesday July 21, 2015, between 12:40 p.m. and 2:50 p.m. in ten-minute intervals. ST-1 was made in the front yard of 575 Franklin Street, opposite the project site of the new law school building. ST-1 was approximately 20 feet from the centerline of Franklin Street. At the time of measurement, the project site of the new law school building, which is currently a parking lot, was fenced off for construction purposes. The construction activities, which included ground clearing and/or excavation equipment, during the ten-minute interval occurred on the far end of the project site, away from ST-1. The ten-minute $L_{eq(10)}$ measured at ST-1 was 56 dBA $L_{eq(10)}$. ST-2 was measured in the front yard of 860 Market Street near the corner at Lafayette Street. ST-2 was approximately 25 feet south of the centerline of Market Street. Heavy vehicular traffic along Lafayette Street and Market Street, which included several heavy trucks, dominated the noise environment at ST-2; however, at the time of measurement, there was construction activity at the entrance of the residential tower opposite Market Street from ST-2. Construction equipment used during the ten-minute measurement interval included a jack hammer, which influenced the measurement at ST-2. The ten-minute $L_{eq(10)}$ measured at ST-2 was 64 dBA $L_{eq(10)}$. ST-3 was made at the Kennedy Commons Mods on campus. The measurement was approximately 65 feet west of the walking path connecting Santa Clara Street and Market Street. The ten-minute $L_{eq(10)}$ measured at ST-3 was 53 dBA $L_{eq(10)}$. The final measurement, ST-4, was made in the side yard of 702 Varsi Place, adjacent to Park Avenue. ST-4 was approximately 30 feet from the centerline of Park Avenue. Some interior renovations were occurring at 702 Varsi Place at the time of measurement. While the construction work was inside, the doors and windows of the residence were open, so the renovation work would have affected the levels measured at ST-4. The ten-minute $L_{eq(10)}$ measured at ST-4 was 58 dBA $L_{eq(10)}$. Table 4 summarizes the results of the short-term measurement.

FIGURE 1 Noise Measurement Locations

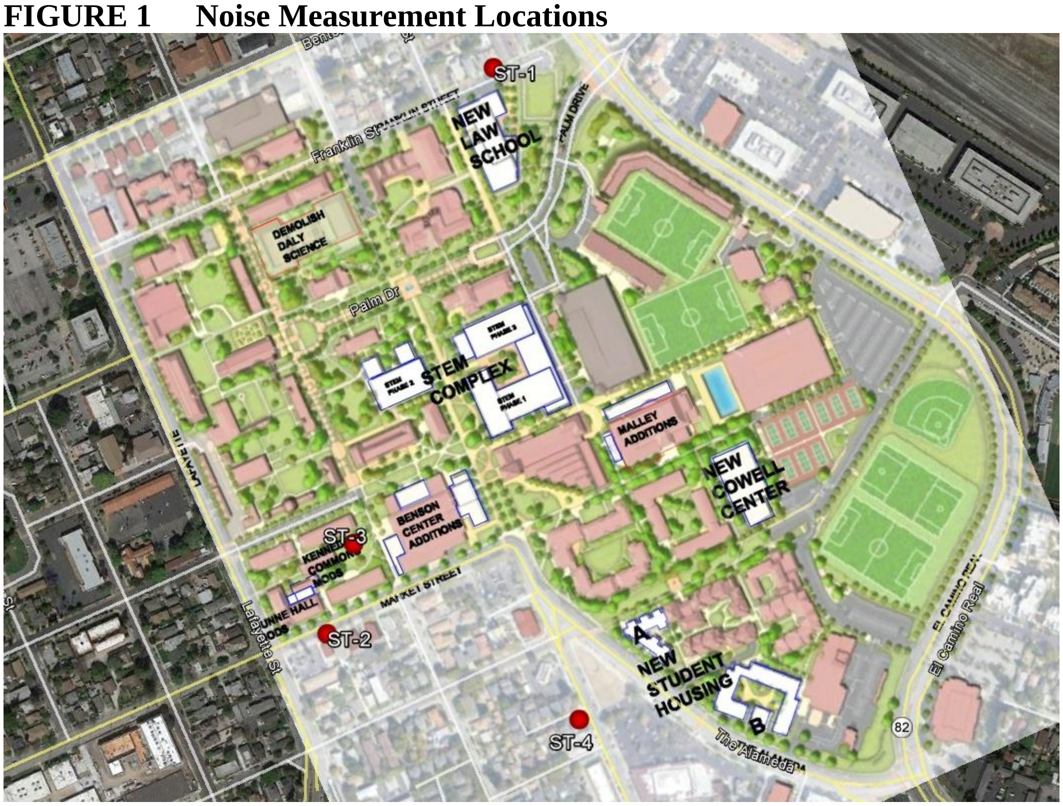

TABLE 4 Summary of Short-Term Noise Measurements (dBA)

Noise Measurement Location (Date, Time)	L_{max}	$L_{(1)}$	$L_{(10)}$	$L_{(50)}$	$L_{(90)}$	$L_{eq(10)}$
ST-1: ~20 feet north of the centerline of Franklin Street (7/21/2015, 12:40-12:50)	63	60	58	55	53	56
ST-2: ~25 feet south of the centerline of Market Street (7/21/2015, 13:30-13:40)	74	73	68	61	56	64
ST-3: At the Kennedy Commons Mods (7/21/2015, 14:00-14:10)	65	63	54	50	49	53
ST-4: ~30 feet west of the centerline of Park Avenue (7/21/2015, 14:40-14:50)	69	66	62	54	50	58

Construction Noise

Noise impacts resulting from construction depend upon the noise generated by various pieces of construction equipment, the timing and duration of noise-generating activities, and the distance between construction noise sources and noise-sensitive areas. Construction noise impacts primarily result when construction activities occur during noise-sensitive times of the day (e.g., early morning, evening, or nighttime hours), the construction occurs in areas immediately adjoining noise-sensitive land uses, or when construction lasts over extended periods of time. Where noise from construction activities exceeds 55 dBA L_{eq} and exceeds the ambient noise environment by at least 5 dBA L_{eq} at noise-sensitive uses in the project vicinity for a period exceeding one year, the impact would be considered significant.

Construction activities generate considerable amounts of noise, especially during earth-moving activities when heavy equipment is used. Table 5 presents the typical range of hourly average noise levels generated by different phases of construction measured at a distance of 50 feet. Typical hourly average construction-generated noise levels for the proposed project would be about 79 to 89 dBA L_{eq} measured at a distance of 50 feet from the center of the site during busy construction periods (e.g., earth moving equipment, impact tools, etc.). Construction-generated noise levels drop off at a rate of about 6 dBA per doubling of the distance between the source and receptor. Shielding by buildings or terrain can provide an additional 5 to 10 dBA noise reduction at distant receptors.

The nearest noise-sensitive receptors surrounding the project site of the new law school building would be 80 feet or greater from the site. At these residences, the hourly average noise levels would range from 71 to 85 dBA L_{eq}. While the existing noise environment was measured during construction activities, the activities were at a distance beyond 150 feet from ST-1. The residents opposite Market Street from the construction sites at Benson Center and Kennedy Commons would be 85 feet or greater from the project sites, with partial shielding provided by existing campus buildings. Under worst-case scenario conditions, which would be adjacent construction with direct line-of-sight to the nearby residences, the hourly average noise levels at 85 feet would range from 70 to 84 dBA L_{eq}. On-campus residential buildings at the Kennedy Commons would also be affected by the construction. The residents of the existing Dunne Hall building would be adjacent to the additions expected at that building. The surrounding residence halls would be range from 40 to 105 feet from the proposed additions. At these distances, the hourly average noise levels would be as high as 77 to 91 dBA L_{eq}. The Kennedy Commons residences would also be within 50 to 95 feet of the Benson Center Additions. At these distances, the hourly average noise levels would be as high as 75 to 89 dBA L_{eq}. While most of the receptors in the vicinity of the new student housing buildings A and B are commercial uses, there are surrounding noise-sensitive receptors 165 to 300 feet or more from these project sites. At these distances, the hourly average noise levels would be as high as 65 to 79 dBA L_{eq}. The existing on-campus residential buildings adjacent to these project sites would be within 40 feet of the construction activities. At these distances, the hourly average noise levels would be 77 to 91 dBA L_{eq}.

Noise generated by project construction would be expected to exceed 55 dBA L_{eq}; however, the City's Municipal Code states that the 55 dBA daytime threshold at single- and multi-residences is not applicable to construction activities conducted during allowable hours. Although construction-generated noise levels would exceed ambient noise levels at receptors surrounding the project sites by more than 5 dBA L_{eq}, construction activities would occur in short-term durations during daytime hours only.

TABLE 5 Hourly Average Noise Levels for Construction Equipment at 50 feet

	Domestic Housing		Office Building, Hotel, Hospital, School, Public Works		Industrial Parking Garage, Religious Amusement & Recreations, Store, Service Station		Public Works Roads & Highways, Sewers, and Trenches	
	I	II	I	II	I	II	I	II
Ground Clearing	83	83	84	84	84	83	84	84
Excavation	88	75	89	79	89	71	88	78
Foundations	81	81	78	78	77	77	88	88
Erection	81	65	87	75	84	72	79	78
Finishing	88	72	89	75	89	74	84	84

I – All pertinent equipment present at site.
II – Minimum required equipment present at site.
Source: United States Environmental Protection Agency, 1973, Legal Compilation on Noise, Vol. 1, p. 2-104.

Mitigation Measure to Reduce Construction Noise Levels

Construction activities for the proposed project should include the following best management practices to reduce noise from construction activities near sensitive land uses:

- Ensure that construction activities within 300 feet of residentially zoned property are limited to the hours of 7:00 a.m. to 6:00 p.m. on weekdays and between the hours of 9:00 a.m. and 6:00 p.m. on Saturdays. No construction is permitted on Sundays or holidays.

- Equip all internal combustion engine-driven equipment with intake and exhaust mufflers that are in good condition and appropriate for the equipment.

- Unnecessary idling of internal combustion engines should be strictly prohibited.

- Locate stationary noise-generating equipment such as air compressors or portable power generators as far as possible from sensitive receptors. Construct temporary noise barriers to screen stationary noise-generating equipment when located near adjoining sensitive land uses. Temporary noise barriers could reduce construction noise levels by 5 dBA.

- Utilize "quiet" air compressors and other stationary noise sources where technology exists.

- Control noise from construction workers' radios to a point where they are not audible at existing residences bordering the project site.

- The contractor shall prepare a detailed construction plan identifying the schedule for major noise-generating construction activities. The construction plan shall identify a procedure for coordination with adjacent residential land uses so that construction activities can be scheduled to minimize noise disturbance.

- Designate a "disturbance coordinator" who would be responsible for responding to any complaints about construction noise. The disturbance coordinator will determine the cause of the noise complaint (e.g., bad muffler, etc.) and will require that reasonable measures be implemented to correct the problem. Conspicuously post a telephone number for the disturbance coordinator at the construction site and include in it the notice sent to neighbors regarding the construction schedule.

Implementation of the above measures would reduce construction noise levels emanating from the site, limit construction hours, and minimize disruption and annoyance. With the implementation of these measures, and recognizing that noise generated by construction activities would occur over a temporary period, the temporary increase in ambient noise levels would be less-than-significant.

Construction Vibration

The construction of the project may generate perceptible vibration when heavy equipment or impact tools (e.g. jackhammers, hoe rams) are used. Construction activities would include site demolition, preparation work, foundation work, and new building framing and finishing. The proposed project would not require pile driving, which can cause excessive vibration.

For structural damage, the California Department of Transportation recommends a vibration limit of 0.5 in/sec PPV for buildings structurally sound and designed to modern engineering standards, 0.3 in/sec PPV for buildings that are found to be structurally sound but where structural damage is a major concern, and a conservative limit of 0.08 in/sec PPV for ancient buildings or buildings that are documented to be structurally weakened. No ancient buildings or buildings that are documented to be structurally weakened surround the project sites. Therefore, ground-borne vibration levels exceeding 0.3 in/sec PPV would have the potential to result in a significant vibration impact.

Table 6 presents typical vibration levels that could be expected from construction equipment at a distance of 25 feet. Project construction activities, such as drilling, the use of jackhammers, rock drills and other high-power or vibratory tools, and rolling stock equipment (tracked vehicles, compactors, etc.) may generate substantial vibration in the immediate vicinity. Jackhammers typically generate vibration levels of 0.035 in/sec PPV, and drilling typically generates vibration levels of 0.09 in/sec PPV at a distance of 25 feet. Vibration levels would vary depending on soil conditions, construction methods, and equipment used. The single- and multi-family residences surrounding the construction sites identified in the proposed project range from 80 to 300 feet from the sites; at these distances, vibration levels would be expected to be 0.06 in/sec PPV or less, below the 0.3 in/sec PPV significance threshold. At the existing on-campus residential buildings, construction activities would be at a distance of 40 to 105 feet, and at these distances, vibration levels would be expected to be 0.13 in/sec PPV or less. Vibration generated by construction activities would at times be perceptible at the nearby sensitive receptors, however, would not be expected to result in "architectural" damage to these buildings. There is proposed construction at the existing Dunne Hall and at the new student housing building A adjacent to existing residential buildings. At these locations, construction activities would be within 25 feet and could potentially have vibration levels exceeding the 0.3 in/sec PPV limit.

TABLE 6 Vibration Source Levels for Construction Equipment

Equipment		PPV at 25 ft. (in/sec)	Approximate L_v at 25 ft. (VdB)
Pile Driver (Impact)	upper range	1.158	112
	typical	0.644	104
Pile Driver (Sonic)	upper range	0.734	105
	typical	0.170	93
Clam shovel drop		0.202	94
Hydromill (slurry wall)	in soil	0.008	66
	in rock	0.017	75
Vibratory Roller		0.210	94
Hoe Ram		0.089	87
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58

Source: Transit Noise and Vibration Impact Assessment, United States Department of Transportation, Office of Planning and Environment, Federal Transit Administration, May 2006.

Mitigation Measure to Reduce Construction Vibration Levels

Prohibit the use of heavy vibration-generating construction equipment, such as vibratory rollers or clam shovel drops, within 25 feet of the on-campus residences adjacent to the project sites. While no fragile campus building were identified near the construction sites, any structural damage to an on-campus building caused by one the construction projects included in the proposed project would be to a building also owned by the University. Therefore, any damages experienced would be the responsibility of the University to fix or repair.

The critical factors pertaining to the impact of construction vibration on existing sensitive receptors include the proximity of the existing structures to the project site, the structural soundness of the existing buildings, and the methods of construction used. Therefore, by prohibiting the use of specific vibration-generating equipment near sensitive receptors, the impact of construction vibration would be minimized.

♦ ♦ ♦

Please feel free to contact us with any questions on the analysis or if we can be of further assistance.

Sincerely,

Carrie J. Janello
Consultant
Illingworth & Rodkin, Inc.